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Benefit Cost Analysis and Economic Flood
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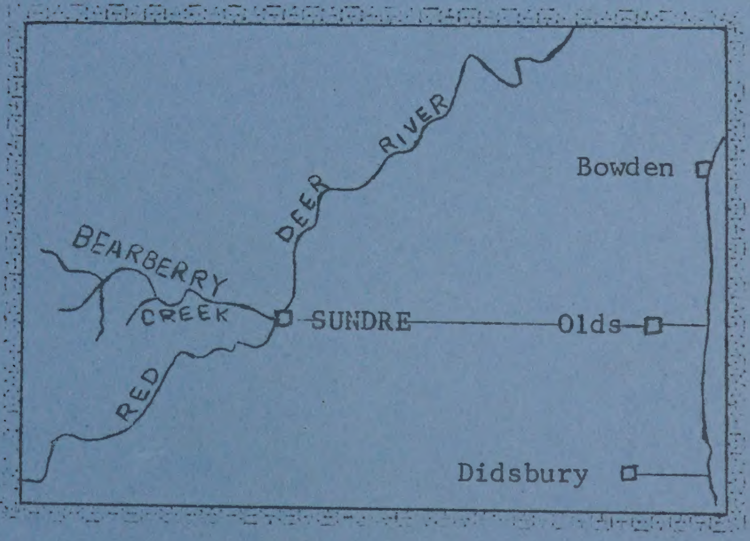

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A BENEFIT COST ANALYSIS
AND ECONOMIC FLOOD SURVEY
BEARBERRY CREEK
SUNDRE, ALBERTA. 1966

G. B. PARLBY

ECONOMICS DIVISION
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SUMMARY

The Bearberry Creek west of Sundre floods periodically causing damage to nine farms upstream and portions of the town. The Water Resources Division proposed a dam upstream to correct the problem. The dam is estimated to cost $1,323,000 dollars. The area was surveyed to determine the benefits. These centered on savings from losses of income and property damage and increases in agricultural production.

The Net Direct Benefit to Project Cost Ratio was estimated at 0.1 to 1.0. This estimate is conservative and does not measure benefits accruing to businesses as a result of the reduction of a flood threat from the Bearberry nor to the town in the extension of facilities. The ratio is based on the 1965 flood alone and thus should be used only as a guide.

ACKNOWLEDGEMENTS

Thanks are expressed to Mr. A. Ogden, Secretary-Treasurer, the Town Council, and the residents of Sundre for their co-operation and patience in providing information for this study.

Appreciation is expressed to Mr. H. Bryce, Mr. R. Miller and the secretarial staff for their help in compiling and printing the results.

TABLE OF CONTENTS

GENERAL. . . . . .Page 1

RURAL ANALYSIS . . . . .Page 7

URBAN ANALYSIS . . . . .Page 10

NET DIRECT BENEFITS. . . . . .Page 15

FLOOD CONTROL BENEFITS
BEARBERRY CREEK

GENERAL

Location

The Bearberry Creek flows into the Red Deer River at Sundre, a town located 30 miles west of Olds, Alberta. The creek's drainage basin originates 15 to 20 miles to the west and thus is local in nature. The creek breaks out onto the McDougall Flats, part of the flood plain of the Red Deer, six miles west of Sundre, and divides into two channels on the boundary of the town limits. A new channel, improved by the Water Resources Division of the Alberta Department of Agriculture, flows through the central part of town while the old channel flows through the south sections.

All references to the town of Sundre in this report refer to that part lying west of the Red Deer River. (See map on page 2).

The Problem

Flash floods, caused by quick snow melts and high local rainfall, result in property damage in some degree to farms upstream and business and residences downstream. Through interviews with local people, a major flood of some proportion can be remembered in each decade since the 1910's.

The town is not in an ideal location as, in addition to threats of flooding from the Bearberry, it faces hazards from the Red Deer River. Flood threats have, according to town officials,[1/] impeded growth and development.

[1/] Interviews with Mayor R. Morris and Councillors.

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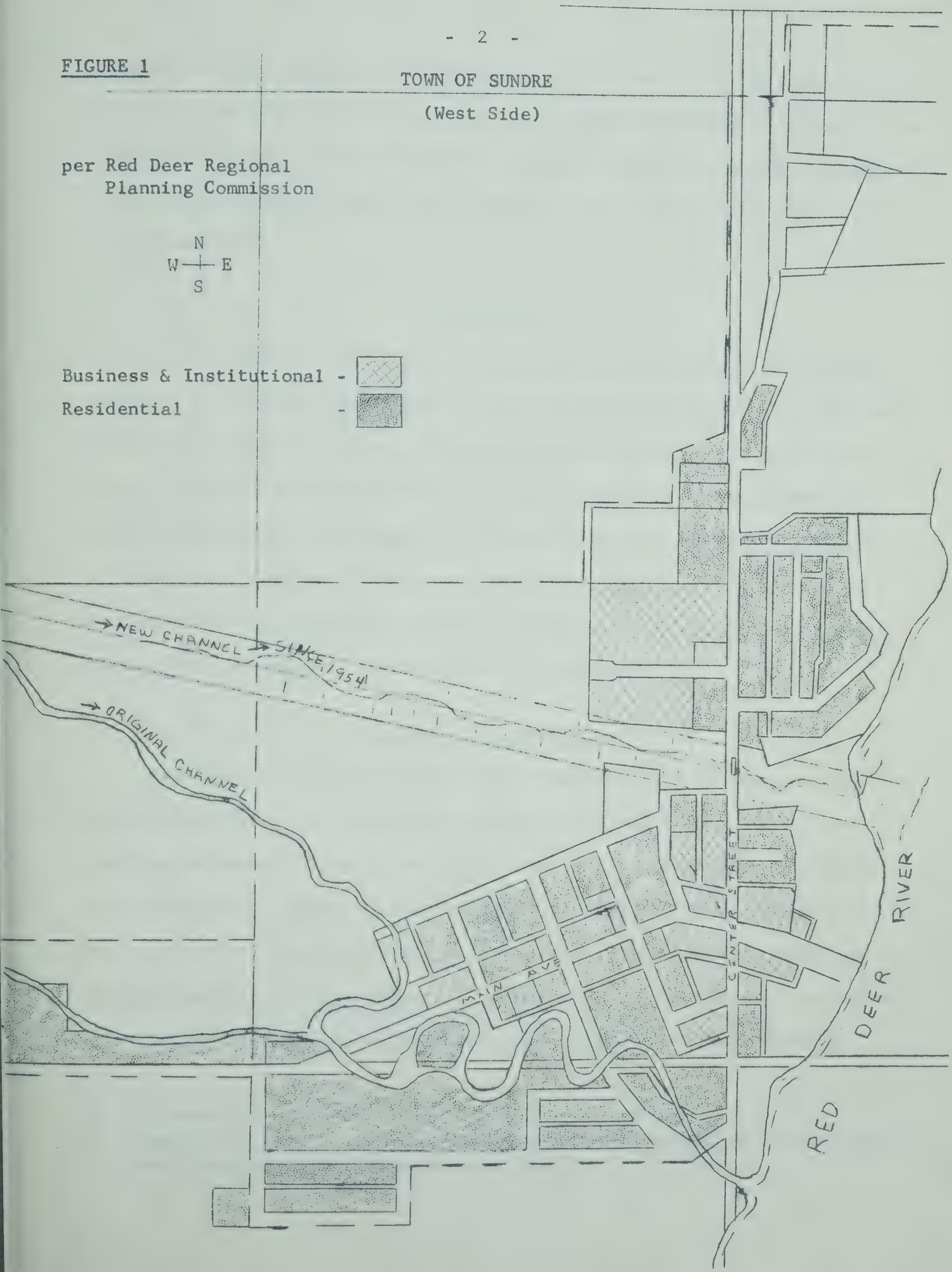
FIGURE 1

TOWN OF SUNDRE

(West Side)

per Red Deer Regional Planning Commission



Planning regulations restrict subdivisions in a flood zone and a large part of Sundre has been classified as such by the Water Resources Division of the Alberta Department of Agriculture.[2/] Insurance against flooding from both river and creek would improve the development possibilities for the town in its present site.

The Proposal

In November of 1966, Water Resources Division requested an economic study of the benefits which would occur from the construction of a proposed dam located 6 miles upstream. The dam would be designed to control peak flows, which the Bearberry channel could not contain. A preliminary engineering report issued in March of 1967 concluded that the dam, as proposed in preliminary design is inadequate and that construction costs would be much more than proposed stream channel improvement.[3/] Since then, investiations have proceeded on stream channel improvement.

Economic Investigations

Economic investigations were begun immediately on the basis of the proposed dam site. As the dam's primary purpose was flood control, the benefits of recreation would be minimal and were not considered. Fluctuating water levels, essential for flood control, are in direct competition with recreation which requires stable water levels. Conservation of water, a possible benefit which at present is unmeasurable, would not apply as stored water would be released as soon as the creek's peak flow had subsided.

[2/] Correspondence, Red Deer Regional Planning Commission.

[3/] Shymoniak J. and T. V. Mussivand, "Preliminary Engineering Report, Proposed Bearberry Creek Flood Control Dam."

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Accordingly, the economic justification for control structures must be found in measuring the benefits of flood control. These benefits can be divided into direct and indirect benefits. The direct benefits of flood protection are two-fold. The first is the reduction in damages and expenditures made to prevent flooding. The second is the increase in income of businesses and wage earners because floods no longer occur. This income is the summation of business losses through decreased sales and wage earners' losses because of unemployment during the flood. As well, in the case of Sundre, the threat of floods may be a cause for businesses or workers to locate away from the town. Reducing the threat of flooding might result in increased benefit to the town as a result of expenditures made by newly located businesses or wage earners who would not be there under flood conditions. From a local viewpoint, the effect of flooding on new business or employment is serious. Provincially, it can be argued that as long as businesses locate in the province, their specific location is not going to affect the province's productivity to any significant degree.

Indirect benefits were not measured for this project.

Procedure

Twelve farms were interviewed upstream. They were contacted on the basis of possible problems due to flooding on the Bearberry. The area owned by these farms is about 5,000 acres.

As the population of property owners in Sundre was small, it was decided to interview all of them on the west side of the Red Deer River. This would provide a delineation of the flood area for Bearberry Creek and determine the extent and seriousness of various floods that have occurred in the

past. Interviews were conducted on a personal basis. Drop questionnaires were used after calling on a property owner twice without success, or in areas where flooding had not occurred for the past twenty years.

One hundred and fifty-eight properties were contacted out of a possible two hundred and eighteen.[4/] The assessed valuation in 1966 dollars for the town, west of the Red Deer was $2,093,000. The value of property in that area that was covered by interview amounted to $1,806,000. Thus information was obtained for eighty-five percent of the property which could be affected by flooding on the Bearberry.

Flood History

Both in the rural area and in the town, the gathering of data for floods previous to 1965 was very difficult. Floods have occurred in 1965, 1954, 1953, 1939, and 1915 according to Water Resources files.[5/] People interviewed reported a major flood about every decade since settlement began in the area.

Data gathering back to 1954 would have significant memory bias. In addition, the composition of the town has changed considerably since 1954. Sundre was the recipient of an oil boom in the fifties. The population has climbed from 337 in 1951, to 923 in 1956, and dropped to 853 in 1961.[6/] Thus the urban area is relatively new and, as Table I indicates, a majority of the residents in Sundre on their present property have lived there less than 12 years.

[4/] Properties with a 1966 assessed value of $200 or less were excluded. Total value excluded amounted to $855.

[5/] Ibid page 4, footnote 3.

[6/] Census - Dominion Bureau of Statistics.

TABLE I

YEARS OF RESIDENCE

SUNDRE AREA

November 1966

Length of Time at present location (years)	Rural	Urban	Length of time in Sundre (years)	Urban
	% of farmers interviewed	% of residents interviewed		% of residents interviewed
0 - 1	8.3	17.1	0 - 1	6.6
2 - 5	25,0	40.2	2 - 5	27.9
5 - 10	8.3	21.4	5 - 10	19.7
11 - 15	8.3	11.1	11 - 15	18.0
16 - 20	8.4	6.0	16 - 20	13.1
21 - over	41.7	4.2	21 - over	14.7

The average length of residence for the area west of the Red Deer River was 6.75 years. The average length of residence in the 1965 flood area was 5.89 years. This indicates a higher turnover of property in the flood area.[7] Interviews for the 1954 flood indicated that it was of greater intensity but, as most residents in the area of flooding were there for a shorter duration than 12 years, no estimate of damages could be obtained.

Information is presented for the 1965 flood on a rural and urban basis.

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[7] See map, page 11.

RURAL ANALYSIS

Between the dam location and the town of Sundre, nine farms were affected to some degree by flooding. On average, the farms contained 432 acres of land, which could be classified as 52% cultivated, 46% native pasture and 2% farmstead and waste. Cow-calf enterprises were the predominant livestock production units on the farms.

To determine the benefits from flood control during the 1965 flood, an estimate of the damages which occurred is required. An estimate of the change in value of agricultural production through a switch in land-use is made, as well, on the assumption that flooding will rarely occur.

Damages

Losses consisted of damages to crops, livestock, land and other physical assets such as buildings requiring repairs or clean up.

Losses occurred on 225 acres; an average of 25 acres per farm. The majority of this land was in cereal and forage crops. Farmers estimated the loss of these crops in 1965 to be $4,430; an average damage of $19.70 per flooded acre. Crop losses were adjusted for savings in variable costs of field operations which were not performed during the flood year. The adjustments were made on the basis of information presented by each individual farmer. The variable cost savings were made on such items as fuel, twine, oil, grease, and labor for stacking bales. Expenditures saved through not completing normal operations were estimated at $510. Net crop losses amounted to $3,920.

Livestock losses,due to flooding in 1965, were minimal and amounted to $290. They consisted of spring calf losses from cow herds.

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The soil profile on the flood plain is alluvial in nature. The base material is washed rock and gravel. Erosion from flooding severely reduces the productivity of the land. Farmers estimated that through the years 56.5 acres of crop land were made unproductive by floods. The average value of crop land reported by farmers was $93.40 per acre. At a 5% interest rate for borrowing, the annual income loss in perpetuity on this land is estimated at $260.

Other losses consisted of the value of labor or materials required for clean-up and repair to assets such as grounds, buildings and fences. Labor was valued at $1.50 per hour based on a hired man working 200 hours for a wage, including perquisites, of $300 per month. The total value of clean-up and repair was estimated at $940.

Change in Productivity

Through the assurance of protection from most floods, six out of the nine farms affected by flooding, would change their cropping pattern from native pasture to cultivated crops such as hay and grain. The acreage involved is 230 acres. Budgets were prepared to estimate the change in income. Only variable costs were considered. The use of this method hinges on the assumption that the small proportion of acreage affected would not influence the farmers decisions on the quantity of machinery, labor and other capital that would be carried on the farm. The increase in annual net direct benefit resulting from the assurance of flood protection amounted to $4,430. (See Table II).

Pasture was valued at the going pasture rental rate times the estimated carrying capacity. A five month pasture period was assumed. The return per

acre was estimated to be $3.40 for pasture. Yields of 36 bushels per acre for barley and 1.5 tons of mixed hay were used. Prices used were $1.00 per bushel for barley and $20.00 per ton for mixed hay. Variable costs were budgeted from various sources including farmers surveyed, production research cost information and listed retail prices for the Olds - Sundre area. The variable cost item for the "with flood control" situation includes an amortized cost of $289 for land clearing and breaking based on a repayment period equivalent to the life expectancy of the dam and a 5% interest rate.

TABLE II

ESTIMATED RURAL PRODUCTIVITY CHANGES

BEARBERRY CREEK FLOOD CONTROL PROJECT

SITUATION	ACRES	CROP	GROSS REVENUE	VARIABLE COSTS	NET INCOME
With Flood Control	230	Tame hay & barley	$ 7701	$ 2489	$ 5212
Without Flood Control	230	Native pasture	782	----	782
Change	---	----	$ 6919	$ 2489	$ 4430

URBAN ANALYSIS

To determine the extent and area of flooding in the town and relate reported damages of the 1965 flood to property values, the west side of the town was divided into 11 sections. The map on page 11 shows the sections which have had water on the grounds. The accompanying Table reports the number of properties that had water on the grounds out of the number interviewed in each section. To classify for water on the grounds, all that was required was that the flow or rise of water from the Bearberry reached the grounds of any piece of property. On the basis of this classification the flood area includes sections 4, 5, 7, 8, 9, 10, and 11.

Severity of Flooding

Questions were asked to determine the severity and extent of flooding. Table III gives the proportion affected and the depths of water involved.

TABLE III

FLOOD AREA, TOWN OF SUNDRE

SEVERITY AND EXTENT OF FLOODING BY THE BEARBERRY CREEK

Description	Proportion of Properties in Flood Area	Depth of water	
		Average	Ranges
	%	inches	inches
Water on Grounds	38.5	11½	1 - 30
Water in Basement	74.0 [8]	26	1 - 84
Water on main floor	7.7	2½	1 - 4

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[8] Basement flooding includes flooding from the Bearberry or ground water or both. Cellars with earth walls and floors were excluded. In the flood area 48.0% of the properties had basements compared to 72.5% in the non-flood area.

FIGURE 2

TOWN OF SUNDRE

1965 Flood

Water on Grounds - ▦

No Water on Grounds - ▒

Section Number	Water on Grounds
1	0 out of 46
2	0 out of 8
3	0 out of 13
4	7 out of 10
5	2 out of 14
6	0 out of 13
7	10 out of 19
8	4 out of 5
9	1 out of 2
10	3 out of 20
11	6 out of 8

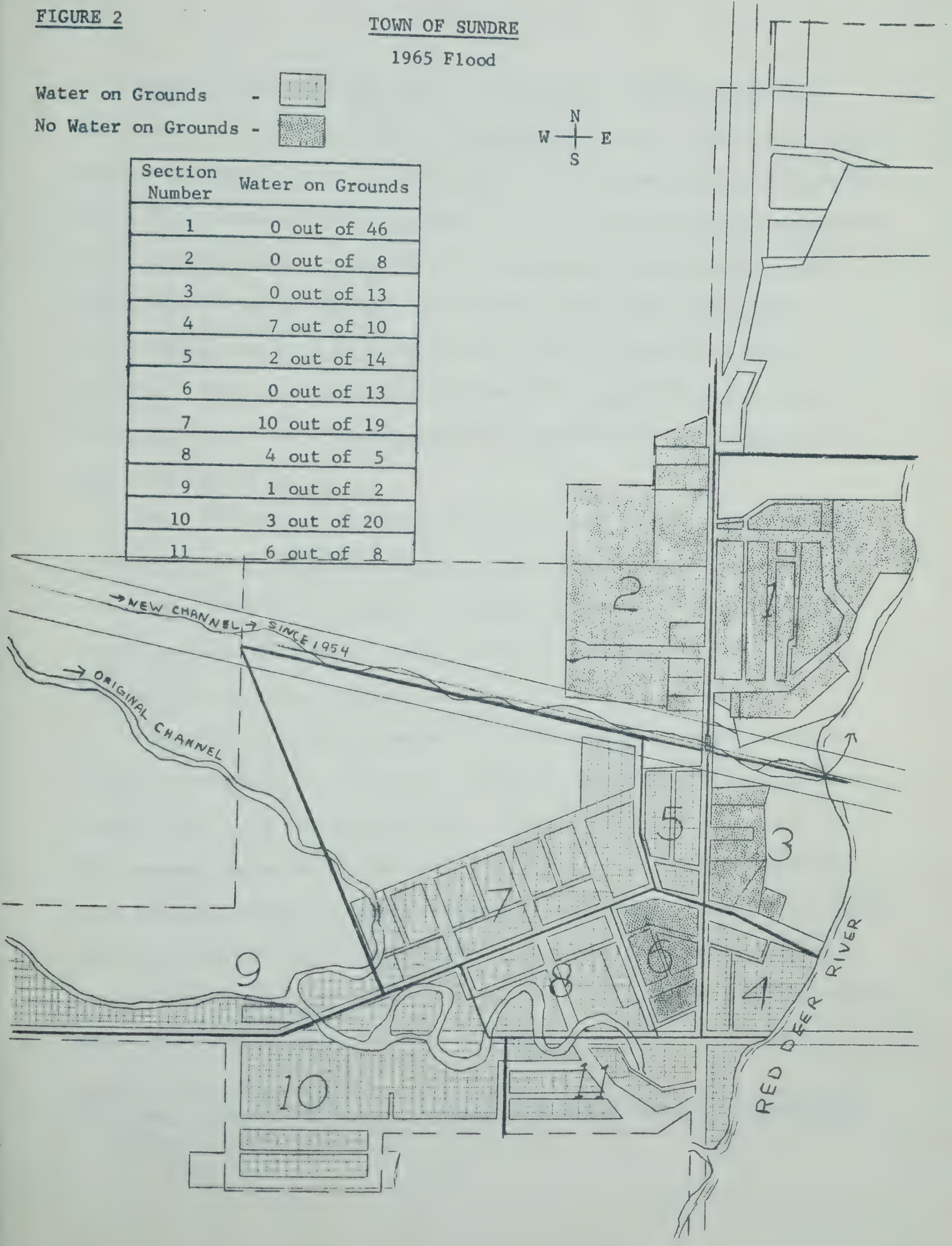

Figure 2. and Table III may be interpreted in the following manner. The flooding in 1965 was a grounds and basement problem. Within the flood area, the properties were affected sporatically. A lower number of basements in the flood area may indicate a history of flooding of higher frequency than in the non-flood area at least as far as groundwater levels are concerned. Mainfloor flooding was minimal. The average height above ground level of the main floor for properties on the west side of Sundre was reported to be 19 inches. This is 6½ inches higher than the average flooding on grounds and would account for a minimum number of properties being affected at the main floor level.

Other indications of the severity of the 1965 flood can be reported by observing that, of those responding in the whole town, 15.8% made changes of some nature to their property to prevent flood losses; 84.2% did not. 14.4% spent time or purchased materials for flood control; 85.6% did not. 9.1% left their premises during the flood; 90.9% did not leave.

Before describing the damages in the 1965 flood, it may be useful to have an appreciation of the value of property and contents which might be affected by any flood from the Bearberry. Property values are based on the 1957 assessed valuation of the town. (See Table IV). They were multiplied by 1½ to bring them up to a 1966 valuation.[9/] The value of contents in buildings was estimated by the people interviewed and extrapolated to the flood area and the west side of Sundre. In any flood, it is likely that the damage which occurs will be less than these figures.

[9/] Personal interview D. McColl, Assessment Branch, Department of Municipal Affairs.

TABLE IV

VALUE OF PROPERTY AND CONTENTS

1966 Dollars

		Flood Area	Sundre West Side
FROM INTERVIEWS:	Assessed Value	$ 388,110	$ 1,121,406
	Value of Contents	502,049	1,198,739
EXTRAPOLATED:	Assessed Value	$ 611,175	$ 2,092,896
	Value of Contents	653,346	2,237,306
	Total	1,264,521	4,330,202

Urban Damages and Losses

Damages were estimated by respondents on property including grounds, basement or cellar, main floor and other incidental items. Time and expenditures made for flood protection and clean-up were estimated. Labor was valued at $1.50 per hour. This was considered a reasonable industrial wage for unskilled labor. [10] Personal and business income losses were reported as well. The total value of damages and losses reported amounted to $8400. These were extrapolated for a final estimate for urban damages and losses for the 1965 flood amounting to $13,200. [11]

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[10] Wage and Salaries, Alberta Bureau of Statistics 1965.

[11] Ratio of assessed value of property in flood area to assessed value of property interviewed in flood zone = 1.57

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Flooding as it Affects Business and Residential Location

The threat of flooding in the town of Sundre both by the Bearberry and the Red Deer has been suggested as a detriment to town growth. At present the Red Deer Regional Planning Commission has restricted town development in a flood zone which includes areas south of the new Bearberry channel. The town has gas, water and sewer facilities developed for extension north of Section 7, Figure #2, page 11. The alternate development is located north of Section 1. No engineering studies have been undertaken to determine the cost of the extension of services to this area.

No measures were made of the benefit from flood control for town development, but the following observations are tendered for consideration. Assuming that development costs in both sections are equivalent, the saving in costs for the extension of facilities to Section 1 could be considered a benefit of flood control. If the threat of flooding from the Red Deer is the main factor impeding development of the town, no amount of work on the Bearberry is likely to increase the amount of new business or employment in the town.

A number of letters were written to establish a picture of this problem. The indications may be summarized as follows. Flood threats have been one consideration for some employees of oil companies in locating outside of Sundre. In the near future, because of a new hospital and further oil development, more housing is likely to be required in or around the vicinity of Sundre. The families who do not locate there because of a flood threat would not spend money in Sundre. The profit from their purchases would be the benefit forgone without the assurance of flood control. This benefit is not measured in this report.

NET DIRECT BENEFITS

In summary, the net direct benefits resulting from the construction of a dam on the Bearberry are two-fold. They are the reduced damages and losses from future floods and the increases in income to the area as a result of flood protection. Information was collected for the 1965 flood and, as such, is insufficient to project a complete picture of the benefits. The following estimate is provided on the basis that policy makers are not likely to wait until floods have occurred often enough to provide the necessary damage information to make their decisions.

All damages from less than a 1 in 30 year flood will be prevented, thus the 1965 flood would be completely controlled. The 1954 flood from all indications had a larger discharge than the 1965 flood. No records for the other 3 recorded floods are available. Therefore an assumption must be made to provide an estimate of the average annual net direct benefits. It is assumed that the 1965 flood was representative of all 5 recorded floods in the past 50 years and thus the $18,350 damage is the mean damage. Thus the frequency would be 0.1. On this basis the average annual benefit in damage prevention can be calculated.

Tables V and VI present information on damages for the 1965 flood and increases in annual income because of reduced flooding. Table VII shows the calculation of net direct benefits.

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TABLE V

Summary of Net Damages and Losses

1965 Flood

Rural:	Crop losses	$ 3,920
	Livestock losses	290
	Other losses	940
	TOTAL	$ 5,150
Urban:	TOTAL	$ 13,200
Total Damages		$ 18,350

TABLE VI

Summary of Increases in Annual Income

Rural:	Changes in Productivity	$ 4,430
	Annual Land Losses	260
Urban:	(not measured or non-existent)	
Total Increases in Annual Income		$ 4,690

TABLE VII

Net Direct Benefits

Total Annual Damages and Losses (18,350 x 5 ÷ 50)	$ 1,835
Annual Increase in Rural Income	4,690
Total Annual Net Direct Benefits	$ 6,780*

* The majority of the benefit that is measured is agricultural resulting from changes in land use.

Engineering Costs

The cost of the dam on the Bearberry has been estimated at $1,323,000. It is assumed there are no annual operation and maintenance charges of any consequence. The annual cost for capital recovery of this dam over 50 years, both for interest on investment at 5% and depreciation is $1,323,000 x 0.05477674 or $72,470. Alternately the present value of a flow of benefits over the next 50 years amounts to $6,780 x 18.25592546 or $123,775. This is the amount that might be expended for the capital cost of construction so that the annual net direct benefits would equal the annual project costs.

Benefit Cost Ratio

The net direct benefit to project cost ratio for the dam on the Bearberry is estimated at 0.1:1 $\left(\frac{\$\ \ 6,780}{\$\ 72,470}\right)$. This does not include unmeasured benefits such as the effect of reduced flooding on town development or indirect benefits such as the return from expenditures made locally on construction of the dam and increased income to the Sundre area because of increased farm expenditures in the local area.

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